

## **Book: Marine Bioacoustic Signal Processing and Analysis**

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### **LONG-TERM GOALS**

As the number of researchers and students entering the field of marine bioacoustics has grown, the types of signal processing, measurement, and analysis have undergone a parallel increase in sophistication. Acoustic signal processing has long been the domain of electrical and mechanical engineers, physicists, and mathematicians. However, more and more biologists and psychologists are starting to use advanced signal processing techniques and analyses, especially with the influx of the many signal processing programs now available. What is lacking for many of these new users is an understanding of the theoretical underpinnings of different techniques. This has happened because the learning curve can be rather steep, especially for those in the biological and psychological sciences, and the theoretical constructs are often ignored or deemed to difficult to comprehend. This also applies to many students and beginning researchers with a physical science background, since various ideas and methodologies are scattered across different texts and manuscripts.

Dr. Whitlow Au, of the University of Hawaii, and I are writing a book on animal bioacoustics that brings together ideas, concepts and methods that are often found in diverse texts and manuscripts. [Dr. Au has a separate ONR grant and is not a co-PI on this one.] We are approaching basic principles from the perspective of processing and analyzing acoustic signals emitted by animals. The book is aimed at advanced undergraduates and beginning graduate students – people with some background in sound analysis who come from a background in either an animal communication or signal processing. Our goal is to make a practical guide by which people can understand and use the tools we have, rather than an theoretical exposition of the frontiers of our field. Such a book, written with animal bioacousticians in mind, is strongly needed in order for the field to grow in fruitful directions.

### **OBJECTIVES**

The objective is to write a technical book on signal processing for bioacoustics, with particular emphasis on the issues faced by marine bioacousticians.

### **APPROACH**

We (Dr. Au and I) are currently working on writing the book. The table of contents for the book has changed a bit, and is now as follows:

## Report Documentation Page

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1. Introduction
2. Introduction to digital signals
3. The Fourier transform
4. Time/frequency representations
5. Filtering
6. Equalization and normalization
7. Measurement and feature extraction
8. Localization
9. Tracking
10. Beamforming
11. Automatic call recognition
12. Call comparison
13. Call synthesis

Appendix: Recording techniques and equipment

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## **WORK COMPLETED**

The text and graphics for Chapters 1-5 is completed, and Chapters 6-11 are in progress. We also have a publisher for the book, Springer-Verlag in New York, and an editor, Jace Harker.

Progress has been slower on these later chapters than it should be, since the project must be finished by Dec. 31. I have started setting aside 2 hours of uninterrupted per workday to work on the remaining chapters.

## **RESULTS**

This project does not really have technical results, as it comprises writing a book.

## **IMPACT/APPLICATIONS**

It is hoped that this book, when published, will help educate a generation of marine bioacoustics researchers about methods for analysis of marine acoustic signals. The existence of a basic text such as this will allow graduate students and advanced undergraduates to learn the fundamentals of bioacoustic signal processing.

## **RELATED PROJECTS**

Whitlow Au has a companion project, with the same name, to co-write this book with me.

Also, Whitlow Au and Mardi Hastings have written an introductory book on bioacoustics. This book was published by Springer-Verlag at the end of 2008.